STUDY OF PERFORMANCE AND EMISSION CHARACTERISTICS OF DIESEL ENGINE USING NEEM-NYJER BIODIESEL

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ABSTRACT

The deficiency of fuel resources and the environmental regulation has led to the development of alternate energy sources for existing fuel resources. In this report the performance characteristics and emission characteristics of a single cylinder four stroke diesel engine when filled with different blends of Neem-Nyjer oil and diesel are evaluated. Different test were conducted with different blends of Neem-Nyjer oil and diesel on various loads. The final results show that Neem-Nyjer oil biodiesel can be used as alternative fuel for diesel without any modification in engine thus Neem oil which is non-edible oil & Nyjer oil as edible oil can be a better renewable raw material for biodiesel production.

Keywords: *Alternate fuels, Blends, Neem-Nyjer oil Biodiesel, Performance, Emission, etc*

1. INTRODUCTION

Biodiesel is fatty acid ethyl or methyl ester made from not used or used vegetable oils (both edible & non-edible) and animal fats. The sources for biodiesel in India as well as in Asia can be non-edible oils obtained from plant species such as Jatropha, Pongamia, and Neem etc. and edible oil such as sunflower, coconut, Nyjer etc. Biodiesel contains no petroleum, but it can be blended at different level with petroleum diesel to create a biodiesel blend or can be used in pure form. Just like petroleum diesel, biodiesel also operates in compression ignition diesel engine which primary require very little or no engine modifications because biodiesel has properties similar to diesel fuels. It can be stored just like the petroleum diesel fuel and that's why does not require separate infrastructure. The use of biodiesel in conventional diesel engines results in valuable reduction of un-burnt hydrocarbons, carbon monoxide and particulate matters. Biodiesel is considered clean fuel because it has almost no sulphur, no aromatics and has built- in oxygen, which helps it to burn fully.

There are more than 360 oil bearing crops identified, among which only Jatropha, sunflower, Soyabean, cottonseed, rapeseed, palm oil and peanut oil are considered as potential alternative fuels for diesel engines. The present study aims to investigate the use of neem-nyjer oil blend with diesel as an alternate fuel for compression ignition engine and it's working with different injection pressure.

2. LITERATURE REVIEW

Lovekush Prasad1, Dr. Agrawal Alka.2 et al [1] In this paper work the performance characteristics of a single cylinder diesel engine when fuelled with blends of Neem oil and diesel are evaluated with different blends (B10&B20). The results show that the brake thermal efficiency of diesel is little higher at all loads followed by different blends of Neem oil and diesel, it has been established that 20% of Neem oil biodiesel can be used as a substitute for diesel.
A. V. Kulkarni, S. D. Bhopale et al [2]. This report shows that good mixture formation and low smoke emission are main key factor for good CI engine performance with properties close to diesel can provide useful substitute for diesel fuel.
G.Sucharitha, A.Kumaraswamy et al [3]. Break thermal efficiency of neem oil, neem oil ester is less than diesel. Increase smoke level and sluggish combustion due to larger droplet size of neem oil. Dharmendra Yadav, Nitin Shrivastava and Vipin Shrivastava et al [4]. The Brake Specific Energy Consumption (BSEC) of Neem oil biodiesel and its blends are higher in comparison to conventional diesel fuel due to its lower heating value and higher viscosity.
M. Kannahi* and R. Arulmozhi et al [5]. The main advantages of biodiesel were environmentally friendliness that has over gasoline and petroleum diesel. The advantages of biodiesel as a diesel fuel were its probability, ready availability, renewability, higher combustion efficiency and higher biodegradability.
Fangrui Maa, Milford A. Hannab et al [6]. In this paper biodiesel production process is described and its properties, also it describes that Biodiesel has become more attractive recently because of its environmental benefits and the fact that it is made from renewable resources. The remaining challenges are its cost, limited availability of fat and oil resources. There are two aspects of the cost of biodiesel, the costs of raw material and the processing cost.
Tejaswita Kajale, Abhay Pawar, Channapatana et al [7]. The objectives of this paper was to investigate the effect of the biodiesel produced from high free fatty acid feed stocks on engine performance & emissions. Biodiesel performance and testing is done in C.I. engine. Results shows that use of biodiesel involves reduction of some emitted pollutants. This is much helpful in reducing pollution caused due to diesel engine emission.
K. Kannan1 and M. Udayakumar2 et al [8]. This study shows that at 5 kW load, the engine brake thermal efficiency found increasing in the order 250_200_150 bar injection pressure and brake specific fuel consumption found decreasing in the order of 250_200_150 bar injection pressure. Though at 150 bar higher brake thermal efficiency & lower brake specific fuel consumption were obtained.
L.Karikalan1 and M.Chandrasekaran2 et al [9]. The present work is to improvise the diesel engine performance by varying fuel injection pressure of J20 biodiesel from 180bar to 240bar through experimental investigation in a single cylinder CI engine. Result shows that J20 biodiesel blend at injection pressure of 240bar with a standard injection timing and with a standard compression ratio gives slightly improved performance and lesser emission when equated to diesel fuel.
Rosli Abu Bakar1, Semin2 and Abdul Rahim Ismail3 et al [10]. When injection pressure increases then fuel particle diameters will become small. Also formation of mixing of fuel to air becomes better during ignition period, engine performance will be increase. If injection pressure is too high then ignition delay period becomes shorter. So that Possibilities of homogeneous mixing decrease and combustion efficiency falls down.
V.S. Hariharan1 and K. Vijayakumar Reddy2 et al [11]. Increasing the injector opening pressure (IOP) from rated value for the diesel (170 bar to 190 bar) resulted in a significant improvement in performance and emissions with Sea lemon oil due to better spray formation.

3. PROBLEM DESCRIPTION:

Due to the increasing demand for fossil fuels and environmental threat, a number of renewable sources of energy have been studied worldwide. An attempt is made to assess the suitability of vegetable/animal oil for diesel engine operation, without any modifications in its existing diesel engine. One of the important factors which influence the performance and emission of diesel engine is injection pressure of fuel. When fuel injection pressure is low, fuel particle diameters will enlarge so that ignition delay period during the combustion will increase. This situation leads to inefficient combustion in the diesel engine and causes the increase in CO, NOX emissions. Engine performance will be decrease since combustion process goes to a bad condition.
This problem is solved by using increase in injection pressure of fuel. And by forming hyperbolic blends of fuel to get better and closer to diesel properties of fuel.

4. MATERIALS AND METHOD:

Biodiesel is ester of vegetable oils produced through a process called transesterification. Transesterification is a chemical reaction in which triglyceride and methyl alcohol reacts in the presence of potassium hydroxide (KOH). It consists of a three consecutive reactions where triglycerides are converted to diglycerides then diglycerides are converted to monoglycerides followed by conversion of monoglycerides to glycerol. In each step an ester is produced and thus three ester molecules are produced from one molecule of triglyceride.

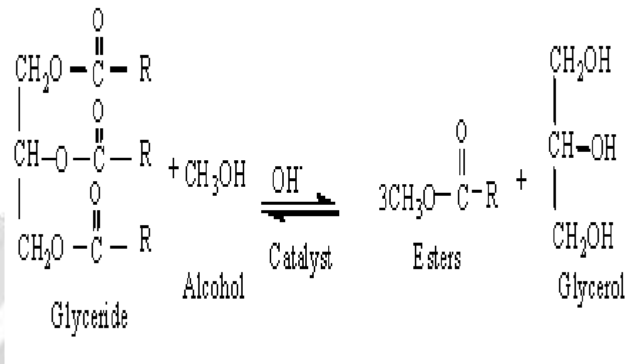


Fig.1 Transesterification Process

1. Transesterification process for Neem oil:
- Acid catalyzed esterification
- Base catalyzed esterification

2. Transesterification process for Nyjer oil:
- Base catalyzed esterification

Since FFA level of Nyjer oil is below 4 hence doesn't required acid catalyzed esterification.

Table 1 Blending of Fuel

Sr. No .	Biodiesel Percentage Neem and Nyjer oil blends	Diesel Percentage	Notation
1	00%	100%	B00
2	20%	80%	B20
3	40%	60%	B40
4	60%	40%	B60
5	80%	20%	B80

Table 2 Properties of Diesel and Biodiesel

Properties	Diesel	Biodiesel
Density	0.83 gm/cc	0.87 gm/cc
Flash Point	44 0C	1460C
Fire Point	49 0C	1540C
Viscocity	3.8 CST	5.9 CST
Cal Value	42000 KJ/Kg	36100 KJ/Kg

5. EXPERIMENTAL SETUP AND PROCEDURE:

A four stroke, 1-cylinder water cooled diesel engine is employed for the present study. The detail specification of the engine used are given in table and experimental set up as shown in figure. Five gas analyzer was used to measure the concentration of different gaseous emissions such as Oxides of nitrogen, unburned hydrocarbon, carbon monoxide, & carbon dioxide level. The performance and emission tests are carried out on the C.I. engine using various blends of biodiesel (Neem-Nyjer oil) & diesel as fuels. The tests are conducted at a constant speed of 1500rpm at various torque. In this experiment, engine parameters related to thermal performance of engine such as brake thermal efficiency, brake specific fuel consumption & exhaust gas temperature are measured. In addition to that, the engine emission parameters such as Oxides of nitrogen, unburned hydrocarbon, carbon monoxide, carbon dioxide and oxygen level.

Table 3 Specification of Engine

Parameters	Specification
Model	TV1
Make	Kirloskar Oil Engines
Type	Four stroke, Water cooled
No. of cylinder	1
Bore diameter	87.5 mm
Stroke length	110 mm
Fuel	Diesel
Compression ratio	17.5:1
Nozzle opening pressure	200 bar

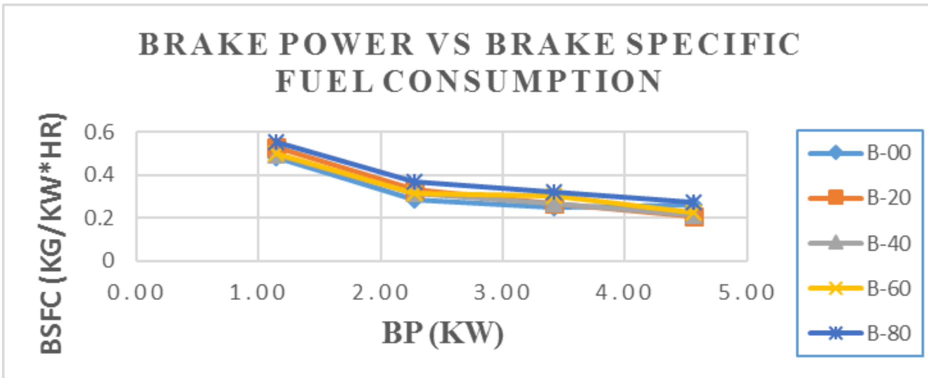
Fig.2 Experimental Set-up

6. RESULT AND DISCUSSION

6.1 Engine performance characteristics

6.1.1 Brake Specific Fuel Consumption (BSFC)

Calorific value of Neem and nyjer oil biodiesel is lower than diesel. Hence the BSFC is slightly higher than that of the diesel for Neem and nyjer oil biodiesel and its blends. The variation of BSFC of Neem and nyjer oil biodiesel and its blends B20, B40, B60, B80, with engine load (Brake power) is shown in graph.

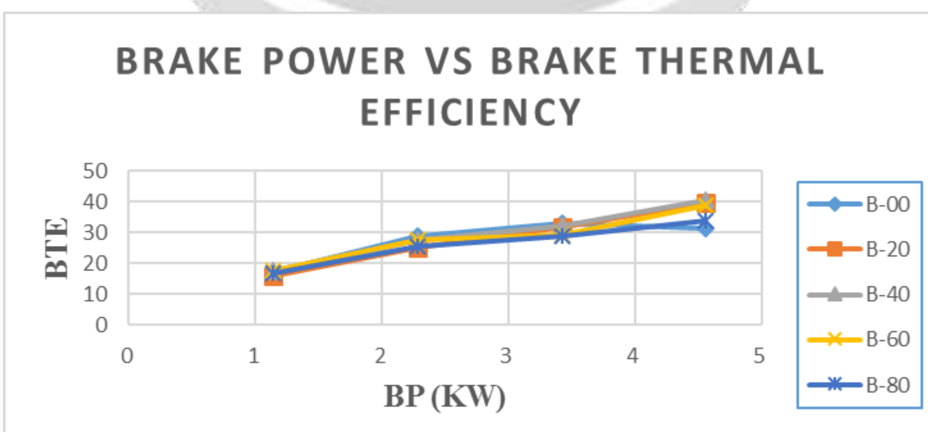


Graph.1 Variation of Brake specific fuel consumption with Brake power

The variation in BSFC with load for different blends of fuels is presented in Graph. Brake-specific fuel consumption (BSFC) is the ratio of mass fuel consumption and brake effective power, and for a given fuel, it is inversely proportional to thermal efficiency. BSFC decreased as increase in load for all fuels. The main reason for this could be that the present increase in fuel required to operate the engine is less than the present increase in brake power, because relatively less portion of the heat is lost at higher loads.

6.1.2 Brake Thermal Efficiency (BTE)

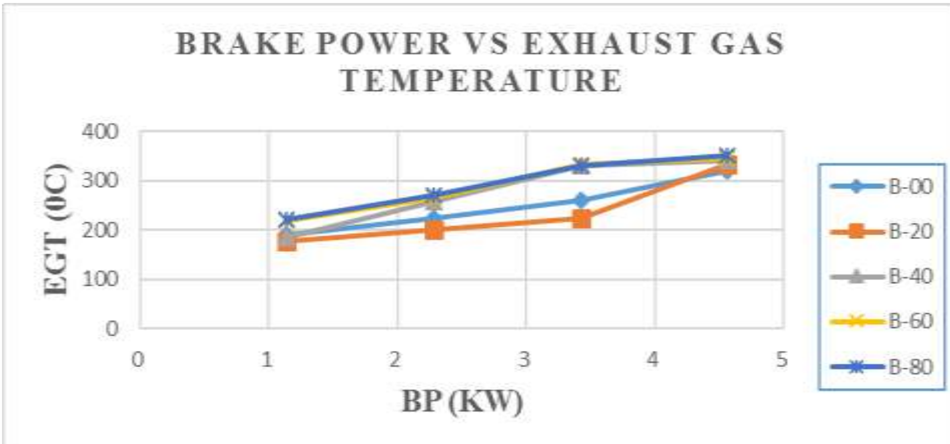
The results obtained from the performance of the engine is demonstrated with the help of graphs. The variation of brake thermal efficiency with load for different blends B20, B40, B60 & B80 is shown in the Graph.
The variation of brake thermal efficiency with load for different blends of fuels is presented in Graph. In all cases, it increased with increase in load. This was due to reduction in heat loss and increase in power with increase in load. The maximum thermal efficiency for B40 (2.01%) was higher than that of diesel. The brake thermal efficiency obtained for B20, B60, and B80 were less than that of diesel. This lower brake thermal efficiency obtained could be due to reduction in calorific value and increase in fuel consumption as compared to B40.



Graph.2 Variation of Brake thermal efficiency with Brake power

6.1.3 Exhaust Gas Temperature (EGT)

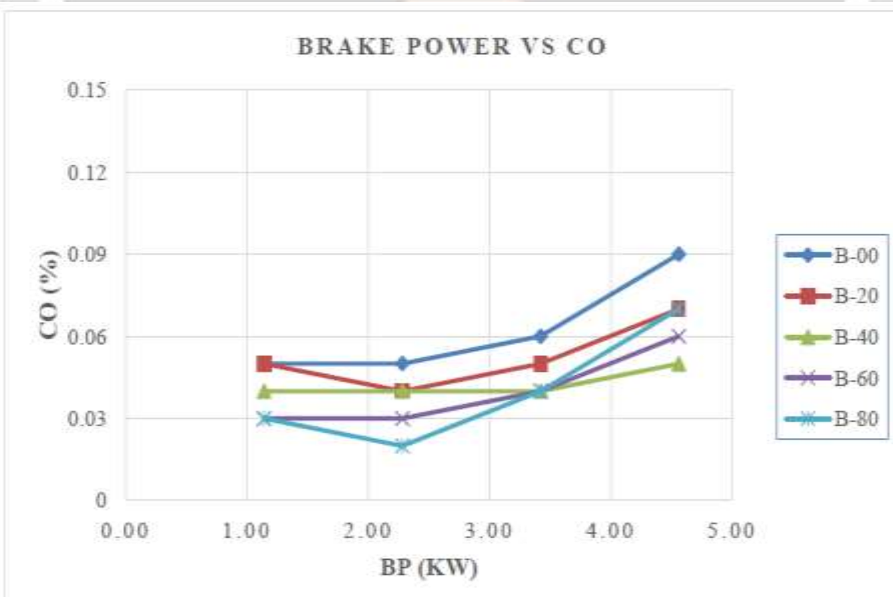
Exhaust gas temperature increases linearly with increase in load. This is due to lower calorific value and higher viscosity coupled with density of fuels. It also increases with increase in the brake power and when compared to diesel the exhaust gas temperature of biodiesel will be more.



Graph.3 Variation Exhaust gas temperature with Brake power

6.2 Emission Characteristics
6.2.1 Carbon Monoxide Emissions (CO)

Variation of CO emissions with engine loading for different fuel is compared in Graph. The minimum CO produced was found in B100 and it was observed that a reduction of 50%, as compared to diesel. Also it is observed that the CO emissions for biodiesel and its different blends are lower than for diesel fuel. These lower CO emissions of biodiesel blends may be due to more complete oxidation as compared to diesel.

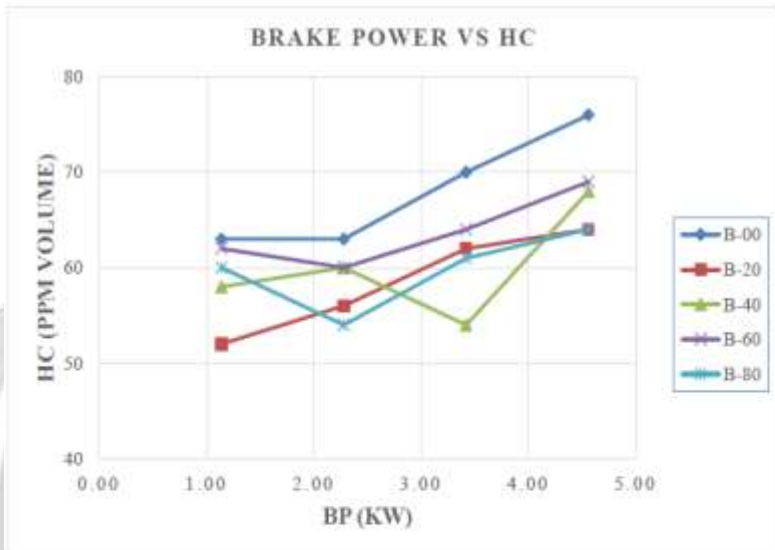


Graph.4 Variation Carbon Monoxide with Brake power

Some of CO produced during combustion of biodiesel might have converted into CO2 by taking up few extra oxygen molecules present in the biodiesel chain and thus reduced CO formation. It can be observed from graph that, the CO initially decreased with load and later increased sharply up to full load. This trend was observed in all the fuel blend tests.

6.2.2 Hydrocarbon Emissions (HC)

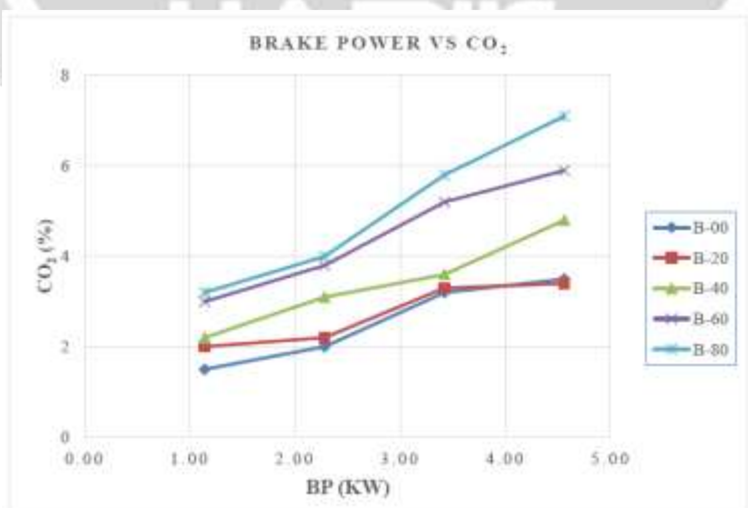
The hydrocarbons (HC) emission trends for blends of neem and nyjer oil and diesel are shown in Graph. The reduction in HC was linear with addition of biodiesel for blends tested. These reductions indicate a more complete combustion of the fuel. The presence of oxygen in the fuel was thought to promote complete combustion.



Graph.5 Variation of Hydrocarbon with Brake power

6.2.3 CO2 Emissions

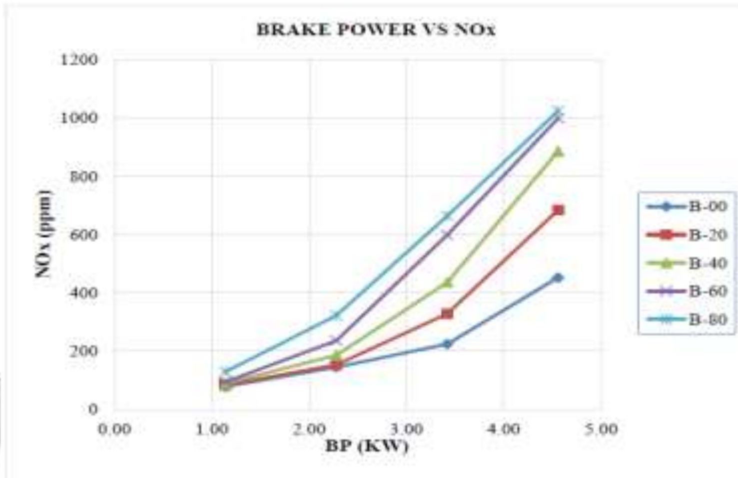
CO2 emission increases as the load increases, the maximum CO2 emission was found in B80 because of complete combustion of fuel as compared to fossil diesel. The CO2 emissions of all other blends were also higher than the conventional fossil diesel.



Graph.6 Variation of CO2 with Brake power

6.2.4 NOX Emissions

The variation of NOX with engine load for different blends of fuels tested is presented in Graph. The nitrogen oxides emissions in an engine are highly dependent on combustion temperature, along with the concentration of oxygen present in combustion products. From graph, it can be seen that an increasing proportion of biodiesel in the blends was found to increase.

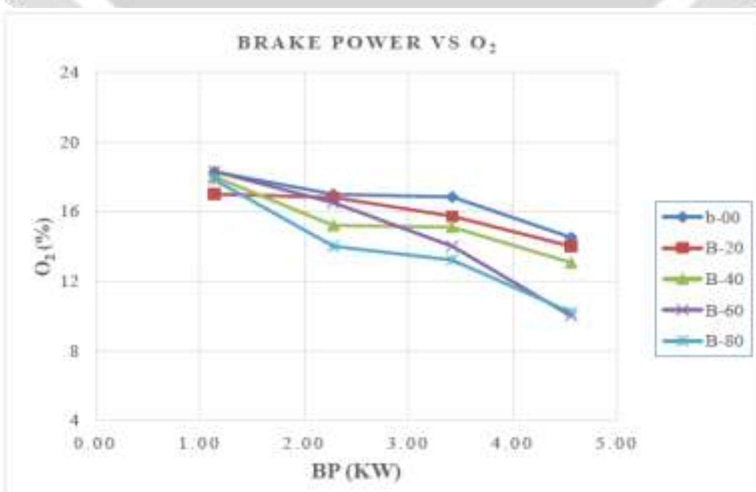


Graph.7 Variation of NOX with Brake power

NOX emissions slightly, when compared with that of pure diesel. In general, the NOX concentration varies linearly with the increase in load of the engine. As the load increases, the overall air-fuel ratio increases, resulting in an increase in average gas temperature in the combustion chamber, and hence NOX formation, which is sensitive to temperature increase.

6.2.4 O_2 Emissions

The graph indicated that the O2 level is comparatively higher in all blends compared to diesel. At all load condition, B100 shows increasing trend with diesel fuel. Level O2 for blends was slightly in increasing order as blend ratio increased. This may be due to the fact that fuels are oxygenated. The fuel have more oxygen content inherent in itself may be the cause of higher O2 level, compared to diesel. The higher O2 level in fuel blends is always preferred.



Graph.8 Variation of O_2 with Brake power

7. CONCLUSION

From the different test of performance and emission characteristics of blends analysis it was found that the blends of Neem-Nyjer oil biodiesel and diesel could be successfully used with acceptable performance up to a certain limit. Based on the result of this study properties of Neem-Nyjer oil suggest that it cannot be directly used as CI engine fuel due to its higher viscosity, density which will result in low volatility as well as poor atomization of oil during oil injection in combustion chamber causes incomplete combustion and carbon deposits in combustion chamber. Up to B40 blend of Neem-Nyjer oil biodiesel shows best performance as compared to diesel and other blends of fuel.

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